

Barnacles (Cirripedia: Thoracica) of seas off the Straits of Gibraltar

by Brian A. FOSTER¹ and John S. BUCKERIDGE

Abstract. — The barnacles collected in dredges and grabs from stations in and off the Straits of Gibraltar (BALGIM 1984 cruise) which were sorted at CENTOB in Brest, are systematically considered. A few other deep-sea barnacles are also considered. Of the eighteen species illustrated, three are new to science. Particular attention is given to species of Scalpellinae with eleven species (two new), and Verrucidae with four species (one new). This paper determines only the species and their biogeography, leaving aside questions of generic categorisation, phylogeny, and the particular ecological and hydrological circumstances of each cruise.

Keywords. — Gibraltar, Poecilasmatidae, Scalpellidae, Verrucidae, Pachylasmatidae, Balanidae, new taxa, biogeography.

Cirripèdes (Cirripedia, Thoracica) récoltés dans les eaux du détroit de Gibraltar

Résumé. — Les Cirripèdes récoltés, principalement à l'aide de dragues et de bennes, au voisinage et dans le détroit de Gibraltar lors de la campagne BALGIM, sont étudiés ici d'un point de vue systématique. Quelques autres Cirripèdes de mer profonde sont également examinés. Tout le matériel étudié a été trié au CENTOB à Brest. Au total dix-huit espèces sont recensées et figurées, trois d'entre elles sont nouvelles pour la science. Une attention particulière est portée aux espèces des sous-familles Scalpellinae, au nombre de onze dont deux nouvelles, et Verrucidae, au nombre de quatre dont une nouvelle. Dans ce travail, nous n'avons considéré que l'identification des espèces et leur biogéographie. Les problèmes posés par les genres et la phylogénie, ainsi que les conditions hydrologiques et les particularités écologiques propres à chaque campagne n'ont pas été abordés.

Mots-clés. — Gibraltar, Poecilasmatidae, Scalpellidae, Verrucidae, Pachylasmatidae, Balanidae, espèces nouvelles, biogéographie.

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INTRODUCTION

This paper reports on a collection of barnacles the late Professor Brian FOSTER received from the Centre national de tri d'océanographie biologique (CENTOB), Brest. They were collected by the BALGIM expedition, during May-June 1984, from either side of the Straits of Gibraltar, particularly into the Ibero-Moroccan Bay of the Atlantic Ocean, by R. V. "Cryos" on behalf of the Centre national de la recherche scientifique (PIROCEAN) under the direction of Dr P. BOUCHET. Eighteen different species of cirripedes, from 126 stations were collected. A further ten samples from various deep-sea cruises in the Atlantic Ocean and three samples from the CORINDON II cruise in Indonesia were also forwarded for determination and contained specimens useful for present purposes. All stations and species data are listed in Appendix A.

1. Deceased, formerly of the Zoology Department, University of Auckland, Auckland, New Zealand.

The main collection results primarily from multiple deep-sea dredging in geographically confined areas, and includes deep-sea material which has been known only from few specimens and inadequate descriptions. The type localities for a number of early descriptions of *Verruca* (*sensu lato*) and *Scalpellum* (*sensu lato*) result from collections from "Talisman" cruises in the Atlantic from the Bay of Biscay to the Cape Verde Islands, "Travailleur" cruises in Mediterranean and the Bay of Biscay, and cruises by the Prince of Monaco in the Azores area (AURIVILLIUS, 1898; GRUVEL, 1900a, 1900b, 1902). The BALGIM material enables a better appreciation of specific variation covered by a number of nominate species described from these early cruises.

This study deals solely with systematics and broad biogeography, leaving bathymetry, hydrology and ecology for later consideration.

The paper is derived from a manuscript submitted to the *Bulletin du Muséum national d'Histoire naturelle*, Paris, prior to Brian FOSTER's untimely death. As the original manuscript incorporated a study of both Indian and Atlantic faunas, it was recommended that it be split, with each geographic area considered separately. The results for the Indian Ocean cruises has now been published (FOSTER & BUCKERIDGE, 1994). This manuscript incorporates any changes in cirripede phylogeny that have occurred since the preparation of FOSTER's manuscript, and further drawings have been added where necessary, ensuring that all described taxa are illustrated.

MATERIALS AND METHODS

The cruise and station data relevant to the various samples are given in Appendix A. In the following systematic treatment, the stations are referred to by the nomenclature on the labels included in the bottles, namely collecting gear and station number. The gear used was as follows: CP, beam trawl; DC, Charcot-Picard dredge; DR, rock dredge; DS, Sanders dredge; DW, Waren dredge; FA, Faubert bottom net trawl; PI, submersible dive or SCUBA diver.

Specimens were sorted at CENTOB and preserved in alcohol. They were examined with the aid of microscopy and dissection. Species regarded as new to science are given a full description. Others are illustrated from specimens, and their anatomy commented on where existing descriptions need amplification or to note points useful in identification. Illustrations of whole animals and shells were drawn with the aid of a drawing tube. Appendages were mounted in polyvinyl lactophenol and drawn with a camera lucida. Segments of cirri and caudal appendages were counted per rami, and where a single average figure is given it has been rounded up to an integer value for the complete rami.

All material is lodged in the Muséum national d'Histoire naturelle (MNHN), Paris.

SYSTEMATIC PART

LIST OF SPECIES

Family Poecilasmatidae Annandale, 1910

Octolasmis nierstraszi (Hoek, 1907)

Poecilasma kaempferi Darwin, 1851

Family Scalpellidae Pilsbry, 1907

Smilium acutum (Hoek, 1883)

Trianguloscalpellum regium (W. Thomson, 1873)

Trianguloscalpellum gigas (Hoek, 1883)

Arcoscalpellum michelottianum (Seguenza, 1876)

Arcoscalpellum crenulatum sp. nov.

Amigdoscalpellum praeceps (Hoek, 1907)

Verum ?minutum (Hoek, 1883)

Meroscalpellum bifurcatum (Zevina, 1973)

Verum novaezelandiae (Hoek, 1883)

Verum frillosum sp. nov.

Ornatocalpellum stroemii (Sars, 1859)

Scalpellum scalpellum (Linnaeus, 1767)

Family Verrucidae Darwin, 1854

Verruca trisulcata Gruvel, 1900

Altiverruca gibbosa Hoek, 1883

Altiverruca vertica sp. nov.

Metaverruca recta (Aurivillius, 1898)

Family Pachylasmatidae Buckeridge, 1983

Pachylasma giganteum (Philippi, 1836)

Family Bathylasmatidae Newman & Ross, 1971

Bathylasma hirsutum (Hoek, 1883)

Family Balanidae Leach, 1817

Megabalanus tulipiformes (Ellis, 1758).

Family POECILASMATIDAE Annandale, 1910

Octolasmis nierstraszi (Hoek, 1907)

(Fig. 1A)

MATERIAL. — CORINDON II: station 263, Strait of Makassar, 80 m (1 specimen).

RECORDS. — HOEK, 1907a: 21, 19 stations East Indies, 16-120 m; NILSSON-CANTELL, 1921: 268, Japan, 135 m; NILSSON-CANTELL, 1927: 762, Persian Gulf; NILSSON-CANTELL, 1934a: 60, Malaysia, 73 m; BROCH, 1931: 40, Kei Is., 38-50 m; HIRO, 1937a: 414, Japan, 24 m (*i.e.*, Persian Gulf, Malaysia to Japan, 16-135 m). FOSTER & BUCKERIDGE, 1994: 348, La Réunion, 75-92 m. On hydroids, etc.

REMARKS

The bilobed tergum and narrowly split scutum clearly distinguish this species, but it is apparent that there is variation in the shape of the basal arm of the scutum, in some cases making the scutum tri-lobed.

Poecilasma kaempferi Darwin, 1851
(Fig. 1B)

MATERIAL. — BALGIM: CP156, 1135 m (1 specimen); DW157, 1108 m (1).

REMARKS

This is a frequently reported species (see ZEVINA, 1982: 98-100 for full records and synonymies; also ROSELL, 1989: 22 for a new Philippines record), as an epizooite on benthic invertebrates, particularly decapod crustaceans, circumglobal, 126-1885 m. The subspecies *aurantia* Darwin, *dubium* Hoek, *litum* Pilsbry and *novaeeangliae* Pilsbry are probably ecotype variants. In specimens collected from the same lobster or crab in New Zealand waters, there is a wide range of shell variations, seemingly associated with position on, or proximity to mechanical disturbances from the various appendages of the host.

Family SCALPELLIDAE Pilsbry, 1907

Subfamily CALANTICINAE Zevina, 1978

Smilium acutum (Hoek, 1883)
(Fig. 1C)

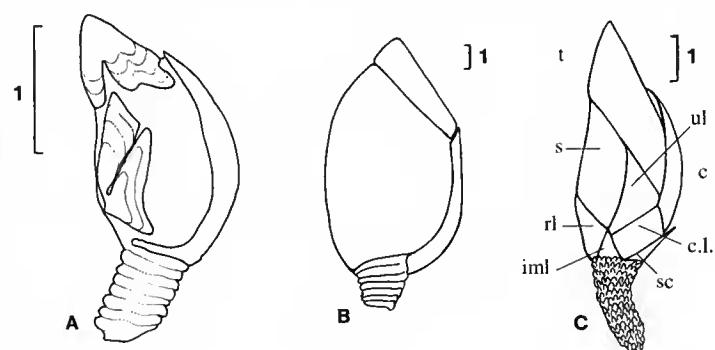
MATERIAL. — BALGIM: CP65, 1805 m (1 specimen); CP68, 2035 m (3); CP69, 2028 m (23); DR82, 355 m (4). BIOGAS V: CP07 (off Cape Finisterre), 2170 m (5). EPI I: CP38 (Gulf of Gascogne), 2100 m (1); CP39, 2175 m (1). BIOCYAN II (Bay of Biscay): PL18, 2000 m (3).

RECORDED DISTRIBUTION. — Circum-global, 61-2480 m. See ZEVINA, 1981: 82 and NEWMAN & ROSS, 1971: 38 for synonymies and references; also ROSELL, 1989: 19, Philippines, 882-770 m.

REMARKS

This widely distributed, frequently encountered and distinctive barnacle was first described by HOEK (1883) from material from both the North Atlantic and the South-West Pacific Oceans. It occurs on a wide variety of substrata, including hydroids, crustaceans, spicules. It nicely

FIG. 1. — Poecilasmatidae and Scalpellidae: A, *Octolasmis nierstraszi* CORINDON II Stn 263. B, *Poecilasma kaempferi* BALGIM, CP156. C, *Smilium acutum* BALGIM, CP69. Scales in mm. Capitular plates: c, carina; s, scutum, t, tergum, ul, upper latus, c.l., carinolatus, rl, rostro-latus, iml, inframedian latus, sc, subcarina. Poecilasmatidae et Scalpellidae: A, *Octolasmis nierstraszi* CORINDON II Stn 263. B, *Poecilasma kaempferi* BALGIM, CP156. C, *Smilium acutum*, BALGIM, CP69. Échelles en mm. Plaques capitulaires: c, carina; s, scutum, t, tergum, ul, latus supérieur, c.l., carinolatus, rl, rostro-latus, iml, latus inframédian, sc, subcarina.



demonstrates the degree of variation in shell morphology (mostly ontogenetic change in capitulum dimensions — the capitulum becoming more elongate and the tergum reflexed, the peduncle with more numerous closely compact scales), and a circum-global distribution in moderately deep water.

The collection of 41 specimens from 8 stations (355-2175 m) in the North Atlantic Ocean of this report is comparable to the 199 specimens from 23 stations (391-1220 m) resulting from New Zealand Oceanographic Institute sampling in New Zealand waters (FOSTER, 1978).

Subfamily SCALPELLINAE Pilsbry, 1907

Trianguloscalpellum regium (W. Thomson, 1873)
(Figs 2A-D, 3)

MATERIAL. — BIOGAS VII (Bay of Biscay): CP28, 3380 m (2 specimens). BIOGAS VIII (Bay of Biscay): CP30, 3100 m (21).

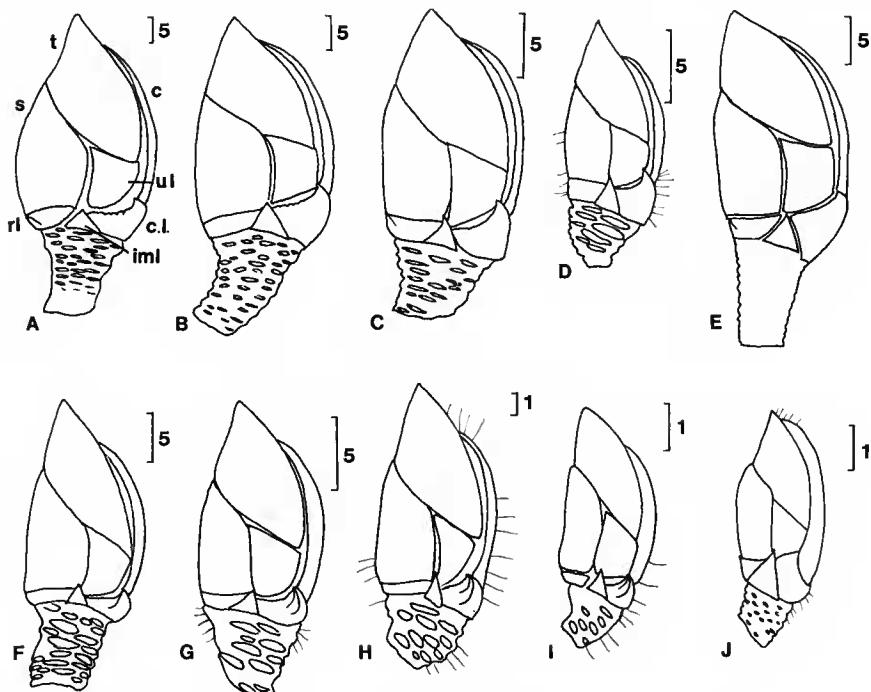


FIG. 2. — Scalpellidae: A-D: *Trianguloscalpellum regium*. A, BIOGAS VII CP30 (47.0 mm c.l.). B, BIOGAS VII CP28, (36.0 mm c.l.). C, BIOGAS VII CP30 (19.0 mm c.l.). D, BIOGAS VII CP30 (11.0 mm c.l.). E, *Trianguloscalpellum gigas* GASCOR, CP42 (22.0 mm c.l.). F-I, *Arcoscalpellum michelottianum* BAGIM, CP95, F, ditto (23.0 mm c.l.). G, ditto, (14.5 mm c.l.). H, ditto, (10.2 mm c.l.). I, ditto (3.6 mm c.l.). Scales in mm.

Scalpellidae: A-D: *Trianguloscalpellum regium*. A, BIOGAS VII CP30 (l.c. = 47,0 mm). B, BIOGAS VII CP28, (l.c. = 36,0 mm). C, BIOGAS VII CP30 (l.c. = 19,0 mm). D, BIOGAS VII CP30 (l.c. = 11,0 mm). E, *Trianguloscalpellum gigas* GASCOR, CP42 (l.c. = 22,0 mm). F-I, *Arcoscalpellum michelottianum* BAGIM, CP95, F, ditto (l.c. = 23,0 mm). G, ditto, (l.c. = 14,5 mm). H, ditto, (l.c. = 10,2 mm). I, ditto (l.c. = 3,6 mm). Echelles en mm.

RECORDS. — THOMSON, 1873: 347, and HOEK, 1883: 106, North Atlantic, 5029-5212 m; GRUVEL, 1920: 30, off Cape Finisterre, 2779 m. Not PILSBRY, 1907a: 28, off Chesapeake Bay, 3740 m, = *T. gigas*, see below. As *molle* AURIVILLIUS, 1898: 191, Azores 845-1023 m; and GRUVEL, 1920: 29, Azores, 4020 m. As var. *ovale* HOEK, 1883: 109, North Atlantic, 5212 m. As var. *latidorsum* PILSBRY, 1907a: 29, off New York, 1812-2940 m. (i.e., North Atlantic, 845-5212 m). FOSTER & BUCKERIDGE, 1994: 355, La Réunion, 4030 m.

REMARKS

The illustrations of 4 specimens from CP30 show the change in capitulum form with growth. The plates maintain close approximation, except for the carinolatera which become more widely displaced from each other below the carina. There is a widening of the lateral aspect of the capitulum to an oval form in larger specimens. The species can reach a large size (47 mm capitulum length and 33 mm peduncle length in the present material). The plates are robust, brownish, with relatively smooth surfaces and faint growth ridges. The carina has obvious lateral sides. The integument between the plates is variously hirsute. The lower latera possess a low profile, with the apex of the carinolatus characteristically curled across the base of the carina to slightly overlap the upper latus at this position in smaller specimens.

The mandible is tridentoid. The segmentation of the posterior cirri increases with size of the animal (Fig. 3); that of cirrus I and the caudal appendages, with lower numbers of segments,

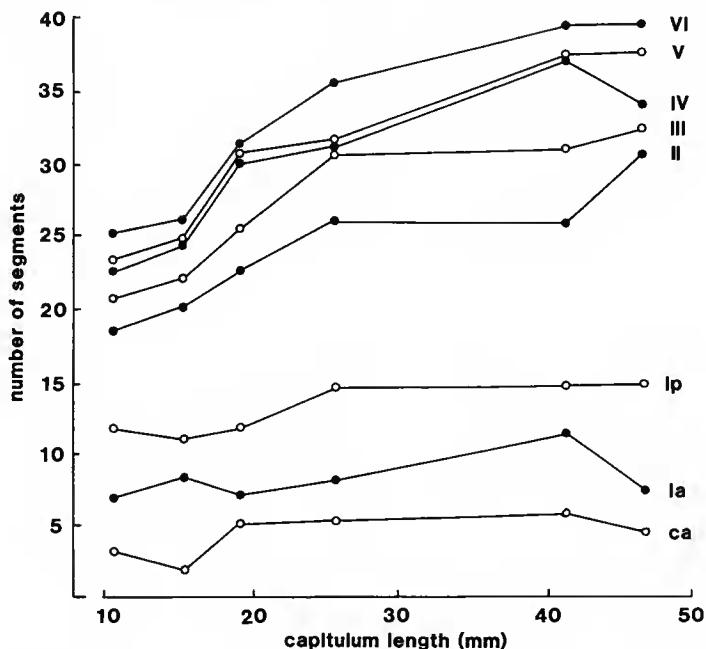


FIG. 3. — Scalpellidae: *Trianguloscalpellum regium* BIOGAS VII CP30. Mean numbers of segments of rami as a function of size of specimen. For anterior (a) and posterior (p) rami of cirrus I (average of 2); all rami of cirrus II-VI (average of 4); both caudal appendages (ca), average of 2.

Scalpellidae: *Trianguloscalpellum regium* BIOGAS VII CP30. Nombres moyens de segments des rames en fonction de la taille des spécimens. Rames antérieure (a) et postérieure (p) du cirrhe I (moyenne de 2 relevés); ensemble des rames des cirres II-VI (moyenne de 4 relevés); ensemble des appendices caudaux (ca), moyenne de 2 relevés.

much more constant. The caudal appendage reaches about 0.5 times the length of the pedicle of cirrus VI. Penis absent. Complemental males carried in interscutal pouches.

Trianguloscalpellum gigas (Hoek, 1883)
(Fig. 2E)

MATERIAL. — GASCOR (Bay of Biscay): CP42, 3815 m (3 specimens).

RECORD. — HOEK, 1883: 102, mid North Pacific, 3749 m.

REMARKS

This species is similar to *T. regium*, but is distinguished by the less rounded profile of the capitulum, with a proportionally longer upper latus and scutum. The plates are less glossy, and the carina is rounded, without lateral sides. Most significantly, this species is a hermaphrodite; it has a penis. The type specimen in the British Museum of Natural History conforms to this.

HOEK (1883) thought that there was a close relationship between *T. gigas* and *T. darwini* (Hoek). This latter species was described on the basis of a single large specimen (48 mm capitulum length, 31 mm peduncle length) from off Chile in the South-East Pacific. Examination of this specimen in the British Museum shows it lacks a penis, and it is more likely that HOEK's *Scalpellum darwini* is *T. regium*, and that PILSBRY's (1907) and ZEVINA's (1981: 309) specimens are *T. gigas*. Both species would thus occur in deep seas around the world.

Arcoscalpellum michelottianum (Seguenza, 1876)
(Figs 2F-H, 4)

MATERIAL. — BALGIM: CP10, 1592 m (14 specimens); CP17, 1470 m (3); CP63, 1510 m (27); CP65, 1805 m (5); CP68, 2035 m (10); CP69, 2028 m (2); CP92, 1182 m (15); CP95, 1378 m (25); CP97, 1515 m (9); CP99, 1870 m (10). EPI VI: KG229 (off Brest), 2160 m (1).

RECORDS. — NEWMAN & ROSS, 1971: 71, off Greenland, 3404-3422 m and off South Carolina, 3010 m; RAO & NEWMAN, 1972, Jonston Atoll, Mid-Pacific Ocean; ROSELL, 1989: 17, Philippines, 682-770 m. As *velutinum* Hoek, 1883: 96, off Cape St Vincent, 1656 m and off Tristan da Cunha, 2606 m; GRUVEL, 1902: 56, off Canary Is, 882-2000 m; PILSBRY, 1907a: 26, western North Atlantic, 64-1962 m; not ANNANDALE, 1913: 229, India, 786 m; = *annandalei* CALMAN, 1918: 109; CALMAN, 1918: 109, Java-Australia, 732-1280 m, and Aden-Zanzibar, 1097 m; GRUVEL, 1920: 27, Azores, 1331 m, off Nova Scotia, 1458 m; BARNARD, 1925: 1, South Africa; NILSSON-CANTELL, 1927: 743, Singapore; BROCH, 1931: 18, off Hong Kong, 760 m; STUBBINGS, 1936: 28, Zanzibar, 690-762 m; ZEVINA, 1972: 43, South-East Pacific, 660-700 m. As *eximum* Hoek, 1883: 100, off Tristan da Cunha, 1828 m. As *sordidum* Aurivillius, 1898: 190, off New Foundland, 1267 m and off Portugal, 2028 m; GRUVEL, 1920: 27, Canary Is, 1098 m. As *erectum* Aurivillius, 1898: 192, Azores 1135-1165 m. As *alatum* Gravel, 1900a: 192, 1902: 57. Distribution is, therefore, circumglobal, 64-3422 m. Long known as *Arcocalpellum velutinum* Hoek, 1883 but synonymised with fossils by WITHERS (1953).

REMARKS

This species is commonly encountered in the Atlantic Ocean (for full synonymy see ZEVINA, 1981: 343 and NEWMAN & ROSS, 1971: 71). NEWMAN & ROSS (1971) gave much needed description of young stages. To further augment the description, particularly with regard to changes that occur during growth, 15 of the specimens from CP95 were dissected, and 4 are illustrated in Figure 2.

This barnacle is hirsute, particularly in young stages, finely so in the larger specimens. The plates are approximate, the capitulum elongate because of an elongate scutum and upper latus (compared with *T. gigas* and *T. regium*). The lower latera are proportionately low, and the apices of the inframedian latus projects above the upper line of the rostro- and carinolatera. The apices of the carinolatera curve towards but do not overlap with the lower carinal border of the upper latus.

Mandibles tridentoid except in one large specimen (21 mm capitulum length) in which a small extra tooth occurs below the upper tooth. Penis absent. The numbers of segments in the rami of the cirri and caudal appendage increase with size of the individuals (Fig. 4). It is interesting to compare the numbers and trends with those of *T. regium* (Fig. 3). Size for size it is not possible to distinguish the two species on this sort of numerical data.

The material includes a solitary juvenile from CORINDON II Stn 248 at 170 m; it is clearly scalpelline, and might be *A. michelottianum*, but without co-occurring adults, identification is uncertain. Isolated juvenile stages of any scalpelline are difficult to identify, because of the similar arrangement of plates in juveniles.

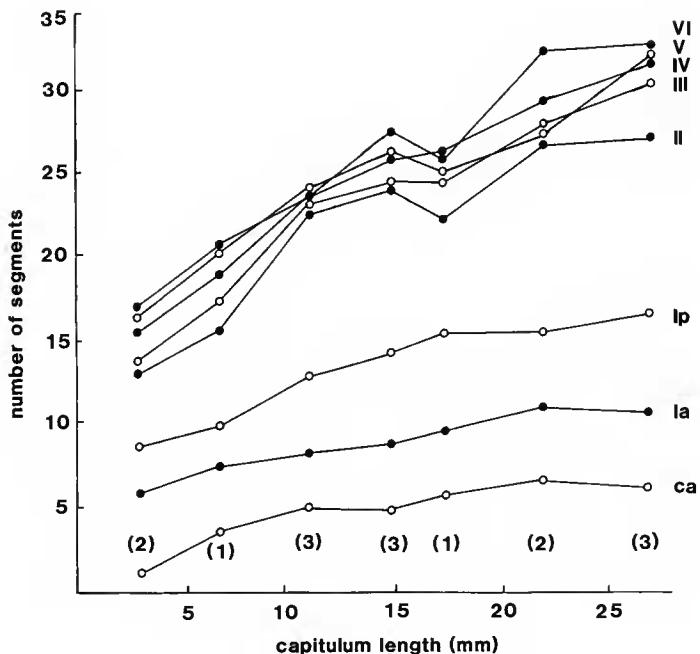


FIG. 4. — Scalpellidae: *Arcoscalpellum michelottianum* BALGIM, CP95. Mean numbers of segments of rami as a function of size of specimen. Average of rami for the numbers of specimens shown above the abscissa.

Scalpellidae : *Arcoscalpellum michelottianum* BALGIM, CP95. Nombres moyens de segments des rames en fonction de la taille des spécimens. Nombre moyen de rames en fonction du nombre de spécimens examinés indiqué au-dessus de l'abscisse.

***Arcoscalpellum crenulatum* n. sp.**
(Fig. 5A-F)

MATERIAL. — BIOGAS VIII (Bay of Biscay): CP30, 3100 m (2 specimens: holotype MNHN Ci 2132; paratype MHNH Ci 2133).

DESCRIPTION OF HOLOTYPE

15.2 mm capitulum length. Capitulum higher than wide. Tergum triangular, apex erect. Carina simply bowed, flat roofed, with strong longitudinal ridges on each side. Scutum quadrangular, apex acute and curved over the tergum, upper margin concave and with secondary growth flange towards the tergum, upper latus margin hollowed out below the upper angle for reception of apex of upper latus. Upper latus pentagonal, with concave margin towards scutum, bearing a narrow rib along this margin, and lower margin mostly abutting the rostrolatus but also touching the inframedian latus. Carinolatus pentagonal, carinal margin concave, and occludent margin projecting slightly beyond the carina below the carina. Inframedian latus triangular, penetrating in these specimens, to the lowest corner of the upper latus. Rostrolatus rectangular, with the lateral margin abutting both the inframedian latus and the upper latus, the margin against the scutum crenulate to the extent of the abutment with the ridge of the upper latus.

Cirri I and II with anterior rami slightly shorter than posterior rami; segments of Ia 1.5 times as wide as those of posterior ramus. Caudal appendages as long as pedicle of cirrus VI. Intermediate segments of posterior cirri with 3 pairs of setae on anterior edge; a single spine on the posterior edge of posterior ramus only.

Segment counts, anterior ramus first:

I	II	III	IV	V	VI	ca
8,9	12,17	17,19	21,17+	23,22	22,26	5
7,11	14,16	18,19	16+,16+	21,21	22,25	5

REMARKS

This species closely resembles *Amigdoscalpellum aurivilli* (Pilsbry) from off Cape Hatteras, and also *Arcoscalpellum pertosum* Foster from New Zealand in the way the plates are apposed.

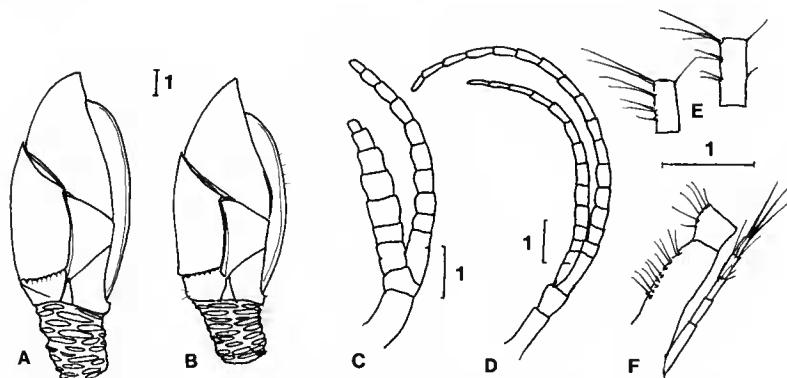


FIG. 5. — Scalpellidae: A-F, *Arcoscalpellum crenulatum* sp. nov. A, BIOGAS VIII, CP30 holotype (15.2 mm c.l.); B, *ditto*, paratype, (13.0 mm c.l.); C, cirrus I; D, cirrus II; E, intermediate segments cirrus VI; F, pedicle cirrus VI and caudal appendage.

Scalpellidae : Arcoscalpellum crenulatum sp. nov. : A, BIOGAS VIII, CP30 holotype (15,2 mm l.c.); B, dito, paratype, (13,0 mm l.c.); C, cirrhe I; D, cirrhe II; E, segments intermédiaires du cirrhe VI; F, partie basale du cirrhe VI et appendice caudal.

However, the crenulate upper margin of the rostrolatus, the penetration of the inframedian latus all the way to the upper latus, and the relatively short occludent margins of the carinolatera below the carina, set the CP30 specimens apart. They are also from deeper water than the above named species.

Amigdoscalpellum praeceps (Hoek, 1907)
(Fig. 6A)

MATERIAL. — BIORAS VIII (Bay of Biscay): CP30, 3100 m (1 specimen). BIORAS XI (Bay of Biscay): CP35, 4720 m (1).

RECORD. — HOEK, 1907a: 114, East Indies, 411 m. FOSTER & BUCKERIDGE, 1994: 356, La Réunion, 1660-2970 m.

REMARKS

This slender barnacle possesses lightly sculptured plates which show, through ontogeny, a widening of the carinal tergal interspace and a reduction of the inframedian latus from full occupation of the space between the rostro- and carinolatera to about 0.2 times of it and displaced outwards in large specimens (FOSTER & BUCKERIDGE, 1994).

Verum? minutum (Hoek, 1883)
(Fig. 6B-F)

MATERIAL. — BALGIM: CP68, 2077 m (13 specimens); CP69, 2028 m (3); CP99, 1870 m (3).

RECORD. — HOEK, 1883: 113, South-East Pacific, 2652 mm; STUBBINGS, 1936: 28, off Zanzibar, 802 m. FOSTER & BUCKERIDGE, 1994: 358, La Réunion, 1850-3520 m.

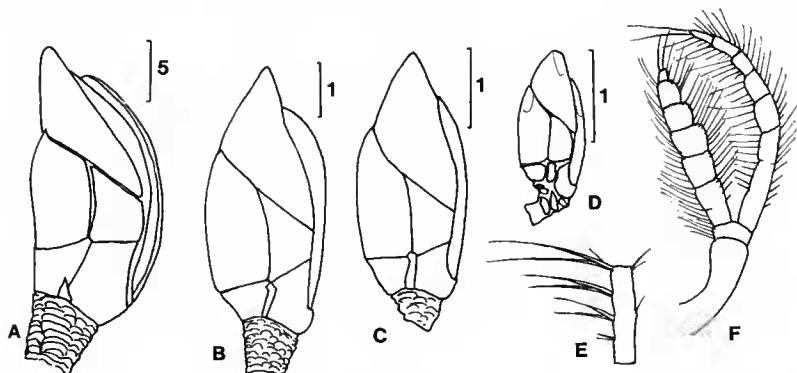


FIG. 6. — Scalpellidae: A, *Amigdoscalpellum praeceps* BIORAS XI, CP35 (27.8 mm c.l.). B-F, *Verum minutum*: B, BALGIM, CP68 (5.8 mm c.l.). C, BALGIM CP69, (3.8 mm c.l.). D, BALGIM, CP99 (2.2 mm c.l.). E, BALGIM, CP68 (4.8 mm c.l.) cirrus I. F, *ditto*, intermediate segment posterior ramus cirrus VI. Scales in mm.

Scalpellidae: A, *Amigdoscalpellum praeceps* BIORAS XI, CP35 (l.c. = 27.8 mm). B-F, *Verum minutum*: B, BALGIM, CP68 (l.c. = 5.8 mm). C, BALGIM CP69, (l.c. = 3.8 mm). D, BALGIM, CP99 (l.c. = 2.2 mm). E, BALGIM, CP68 (l.c. = 4.8 mm) cirrus I. F, *ditto*, segments intermédiaires de la rame postérieure du cirrhe VI. Échelles en mm.

REMARKS

Barnacle small, slender, non-hirsute, with smooth, non-striated plates, and faint growth ridges. Scutum and upper latus elongate, without secondary growth flanges. Carina slightly bowed in upper part. Tergum elongate, apex not curved. Carinolatus slightly higher than wide. Rostrolatus quadrangular, with slight convexity on occludent margin. Inframedian latus very narrow, slightly wider near the upper extremity, umbo apical, and with very short scutal and upper latus margins. The apex of the inframedian latus is club-shaped, tipped towards the rostral margin, and displaced slightly from it in larger specimens (FOSTER & BUCKERIDGE, 1994).

Meroscalpellum bifurcatum (Zevina, 1973) (Fig. 7A, B)

MATERIAL. — BIOGAS XI: CP35 (off Tristan da Cunha), 4720 m (1 specimen). WALDA: CY09 (off Angola), 4613 m (1).

RECORD. — ZEVINA, 1973: 1003, Indian Ocean, 4151 m (in ZEVINA, 1981: 175).

REMARKS

This is one of the scalpellines which show in the adult form variously reduced plates and marked cuticular spaces between these plates. ZEVINA (1981) gives illustrations of 11 mm and 20 mm capitulum length specimens. Not only does the degree of capitular plate coverage decrease in larger specimens, but the shapes of the plates themselves (except the carina) are increasingly irregular.

Similar sequences of capitulum variations and changes have been documented for *Neoscalpellum debile* (Aurivillius) by ZEVINA (1981) and for *Litoscalpellum intermedium* (Hoek) by FOSTER (1980). These instances serve as examples of the problems associated with a taxonomy based on isolated specimens, and possible confusions among generic assignments.

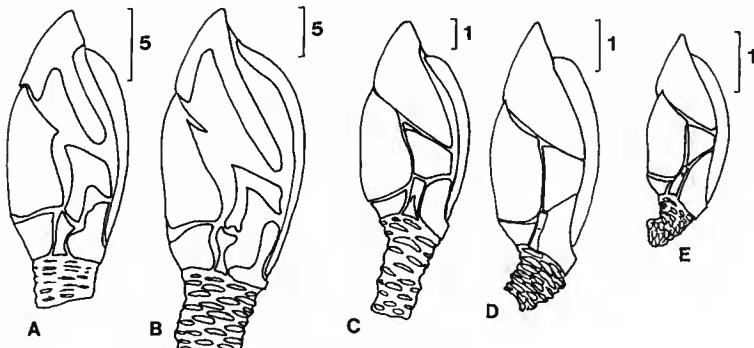


FIG. 7. — Scalpellidae: A, *Meroscalpellum bifurcatum* WALDA, CY09 (16.2 mm c.l.). B, ditto, BIOGAS XI, CP35 (29.6 mm c.l.). C-E, *Verum novaezelandiae*: C, EPI I, CP39 (7.6 mm c.l.). D, ditto (6.0 mm c.l.). E, ditto (4.0 mm c.l.). Scales in mm. Scalpellidae: A, *Meroscalpellum bifurcatum* WALDA, CY09 (l.c. = 16.2 mm). B, ditto, BIOGAS XI, CP35 (l.c. = 29.6 mm). C-E, *Verum novaezelandiae*: C, EPI I, CP39 (l.c. = 7.6 mm). D, ditto (l.c. = 6.0 mm). E, ditto (l.c. = 4.0 mm). Échelles en mm.

Verum novaezelandiae (Hoek, 1883)
(Fig. 7C-E)

MATERIAL. — BALGIM: CP10, 1592 m (1 specimen). EPI I: CP38 (Bay of Biscay), 2100 m (14); CP39, 2100 m (7). CORINDON II (Makassar Strait): Stn 236, 1730 m (1).

RECORDS. — HOEK, 1883: 124, New Zealand, 1280 m; GRUVEL, 1902: 54, off Portugal, 2400-2500 m; ANNANDALE, 1908 & 1913: 231, off Andaman Is, 896-2800 m; CALMAN, 1918: 123, Gulf of Aden, 2195 m; WELTNER, 1922: 71 East-African coast, 1289-1644 m; FOSTER, 1978: 65 & 1980: 530, New Zealand, 455-2431 m.

REMARKS

This species was well represented in collections from New Zealand (FOSTER, 1978, 1980). It is clear that this deep water species is widespread. The present records confirm the Atlantic Ocean records of GRUVEL (1902).

V. novaezelandiae is recognised by the very slender capitulum in which the carinolatus is markedly elongated to match a pronounced apical growth of the inframedian latus. This latter plate remains narrow, with clear edges to the upper latus and scutum. With growth, the umbo of the inframedian latus is placed closer to the basal margin. In some specimens the rostrolatus is very narrow, particularly if growth of the peduncle has been bent to the rostral side.

Appendage counts for CP39 specimens are as follows:

cl(mm)	Ia	lb	II	III	IV	V	VI	ca
4.8	6	8	14	14	15	17	17	4
6.0	7	9	14	17	16	18	20	5
7.6	8	11	15	19	—	24	—	6

The appendage details conform to New Zealand specimens (FOSTER, 1978).

Verum frillosum nov. sp.
(Fig. 8)

MATERIAL. — BIOGAS VII: CP28 (Bay of Biscay), 3380 m (1 specimen, holotype MNHN Ci 2135).

DESCRIPTION OF HOLOTYPE

18.0 mm capitulum length. Peduncle only partially intact, scales wide. Tergum triangular, apex recurved, dorsal margin notched for reception of carina. Carina simply bowed. Scutum pentagonal, upper margin with secondary growth flange against tergum, lateral margin slightly concave, lower margin sinuous in conjunction with rostro- and inframedian latus. Inframedian latus hourglass-shaped, upper part wider than lower part, with sinuous margins to scutum and upper latus. Upper latus pentagonal, upper margin with secondary growth flange towards apex, margins to inframedian- and carinolatus sinuous. Carinolatus higher than wide, upper margin sinuous, occludent margin beneath carina short. Rostrolatus broadly quadrangular.

Mandible tridentoid, lower angle acuminate. Maxillule with 2 stout spines at upper angle, bunch of shorter spines at lower angle. Cirrus I with anterior ramus intermediate segments 2 times

width of those of posterior ramus. Mean numbers of segments in cirri as follows, anterior ramus first:

I	II	III	IV	V	VI	ca
8,12	16,19	20,20	24,24	24,24	25,25	3

Intermediate segments cirrus VI with 5 pairs of setae on anterior edge, no setae midway on posterior edge. Caudal appendages 2-3 segments, just longer than pedicle of cirrus VI.

REMARKS

This barnacle is similar to *Verum constrictum* but lacks constricted rostralatera, and the growing edges of the upper latus, rostralatus, carinolatus and inframedian latus are sinuous in accord with the alternating and interlocking growth ridges of these plates.

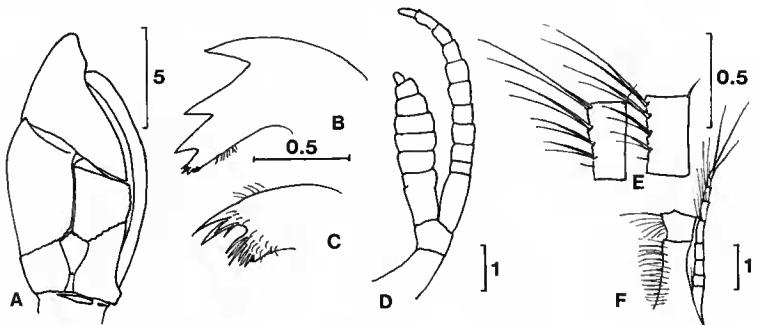


FIG. 8. — Scalpellidae: *Verum frillosum* sp. nov. BIOGAS VII, CP28: A, capitulum holotype (18.0 mm cl). B, mandible. C, maxillule. D, cirrus I. E, intermediate segments anterior and posterior rami cirrus VI. F, pedicle cirrus VI and caudal appendage. Scales in mm.

Scalpellidae: *Verum frillosum* sp. nov. BIOGAS VII, CP28: A, capitulum holotype ($Cl = 18.0\text{ mm}$). B, mandible. C, maxillule. D, cirrus I. E, segments intermédiaires des rames antérieure et postérieure du cirrhe VI. F, partie basale du cirrhe VI et appendice caudal. Echelles en mm.

Ornatoscalpellum stroemii (M. Sars, 1859) (Fig. 9A)

MATERIAL. — BALGIM: DR82, 355 m (3 specimens).

RECORDS. — HOEK, 1883: 73, northern Atlantic Ocean, 152-944 m; PILSBRY, 1907a: 21, North American fishing banks, 143-214 m; and other references in ZEVINA, 1981: 111. As *pressum* Pilsbry, 1907a: 23, Le Havre Bank, 549 m. As *septentrionale* Aurivillius, 1892: 128 and 1894: 51, North Sea, 590-890 m. As *erosum* Aurivillius, 1892: 119 and 1894: 52, North Atlantic, 1744 m. As *obesum* Aurivillius, 1892: 119 and 1894: 56, North Sea, 110 m. As *luridum* Aurivillius, 1892: 120 and 1894: 59, Baffin Bay, 309 m.

REMARKS

The synonymy of 4 of AURIVILLIUS' (1892, 1894) and 3 of PILSBRY's (1907a) names within *O. stroemii* (see ZEVINA, 1981: 111) illustrates the variation within at least some of the scalpelline

species, and the tendency to name this variation by early taxonomists. PILSBRY (1907a: 21) was troubled about HOEK's (1883) illustration of the species, particularly the latter giving the impression that the scutum, inframedian latus and upper latus have subcentral umbos, and also with the proportions of the upper latus. There may have been some over-artistry in HOEK's plates (not confined to this species), but the fact is that during ontogeny the position of the umbo of the inframedian latus becomes progressively displaced from the apex, and both the upper latus and carina also develop apical growth zones. The rectangularly bent carina, in its upper part, results from displacement of the umbo, as it is in *Scalpellum scalpellum*.

This is a relatively shallow water scalpelline, often collected in fishing trawls. Stn DR82 is off the Morocco coast, and is a southernmost record of the species.

Scalpellum scalpellum (Linnaeus, 1767)
(Fig. 9B-D)

MATERIAL. — BALGIM: CP103, 347 m (21 specimens).

RECORDS. — North-East Atlantic, Norway (68°N) to Congo (6°S), 50-366 m; Mediterranean (RELINI, 1980: 93, Italian seas, to 400 m). See ZEVINA, 1981: 95 for synonymies and references.

REMARKS

Of all the 18 species considered in this collection, this is the only one in which the umbo of the scutum is displaced from the apical position. The relatively square lateral shape of the capitulum is produced by considerable subapical displacement of the umbos of the carina and upper latus.

This is a relatively shallow occurring barnacle. It is frequently encountered on hydroids and hydroid-like growths on trawling grounds, and is a well-known barnacle to European marine naturalists. This is the only known species of the Scalpellinae from the Mediterranean Sea (RELINI, 1980).

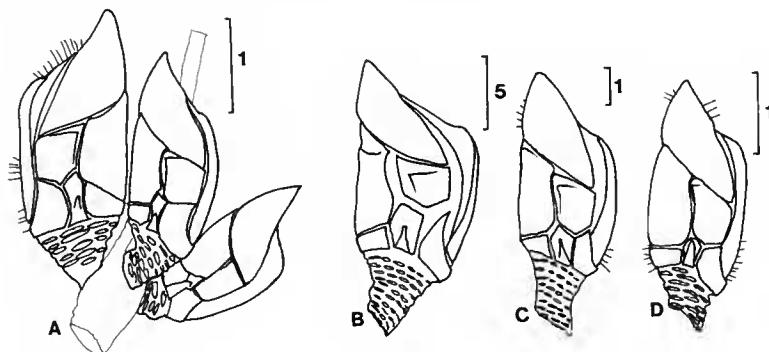


FIG. 9. — Scalpellinae: A, *Ornatoscalpellum stroemii* BALGIM, DR82, group, largest 5.5 mm c.l. B, *Scalpellum scalpellum* BALGIM, CP103 (13.5 mm c.l.). C, ditto (6.2 mm c.l.). D, ditto (3.0 mm c.l.). Scales in mm.

Scalpellinae: A, *Ornatoscalpellum stroemii* BALGIM, DR82, plus grand individu du groupe l.c. = 5,5 mm. B, *Scalpellum scalpellum* BALGIM, CP103 (l.c. = 13,5 mm). C, ditto (l.c. = 6,2 mm). D, ditto (l.c. = 3,0 mm). Échelles en mm.

Family VERRUCIDAE Darwin, 1854

DISCUSSION

There are 83 named species of verrucid (BUCKERIDGE, 1994, FOSTER & BUCKERIDGE, 1994). They are asymmetrical sessile barnacles having a shell wall composed of carina, rostrum, fixed scutum and fixed tergum, and an operculum of movable tergum and movable scutum. Nomenclature of these plates is shown in Fig. 10A. A fuller discussion of the morphology and genera is available in BUCKERIDGE (1994).

The present material is particularly rich in verrucids, both in the number of determined species (4) and individuals (420). Furthermore, the BALGIM collections are in the locality from which AURIVILLIUS (1898) and GRUVEL (1900b, 1902, 1905, 1912) named and/or described many species.

Verruca trisulcata Gruvel, 1900
(Figs 10, 11, 12)

MATERIAL. — BALGIM: CP90, 890 m (9 specimens); CP91, 948 m (4); CP92, 1182 m (70); CP95, 1378 m (22); CP156, 1135 m (252); DW157, 1108 m (28); CP160, 1350 m (9).

RECORDS. — GRUVEL, 1900b: 243; 1902: 96; 1920: 44, Azores, 998 m. GRUVEL, 1912: 348, Cape Spartel (Straits of Gibraltar), 622 m. As *imbricata* Gruvel, 1900b: 244, 1902: 105, Azores, 441 m. As *striata* Gruvel, 1900b: 244; 1902: 98, Cape Verde I, 633 m. As *radiata* Gruvel, 1900b: 262, 1902: 94, Canaries, 912 m; FOSTER & BUCKERIDGE, 1994: 363, La Réunion, 980-1690 m.

REMARKS

A range of shell forms is illustrated to show the range from low splayed (half as high as wide) to quite upstanding (higher than wide) posture. Of 26 shells from CP92 (Fig. 11) the height: width ratio ranges from 0.5 to 1.0, with no significant trend with size of specimen. Also, with growth, the number of interlocking ribs between the movable tergum and scutum, and between the carina and rostrum, increases from 1 in juveniles to 4 in specimens of about 6 mm rostrocarinal length. A characteristic feature of the shell is the particularly wide superior rib on the rostrum. The apices of the rostrum and carina are never turned inwards. The “back” view (*i.e.* of the fixed tergum and scutum) is highly variable; tall with easily discernable alae and radial growth areas, or squat and contorted depending on irregularities of substratum. Movable scutum apex curved over the superior articular groove, with a moderately deep apical pit internally. Movable tergum broadly quadrangular, 1.5 times width of scutum, lower angle protruding as apical ridge.

Mandible tridentoid, with a pectinate lower edge. Maxillule with an irregular cutting edge, the lower angle protuberant (a feature common in verrucids). Cirrus I anterior ramus just over 0.5 times length of posterior ramus. Cirrus II anterior ramus less than 0.5 times length of posterior ramus. Cirrus III-VI with subequal rami. Caudal appendage about 0.66 times length of cirrus VI. Plots of the numbers of segments per rami (Figure 12) show increasing numbers of segments in all rami with increasing size of the specimen. Caudal appendage 0.5 times length of cirrus VI.

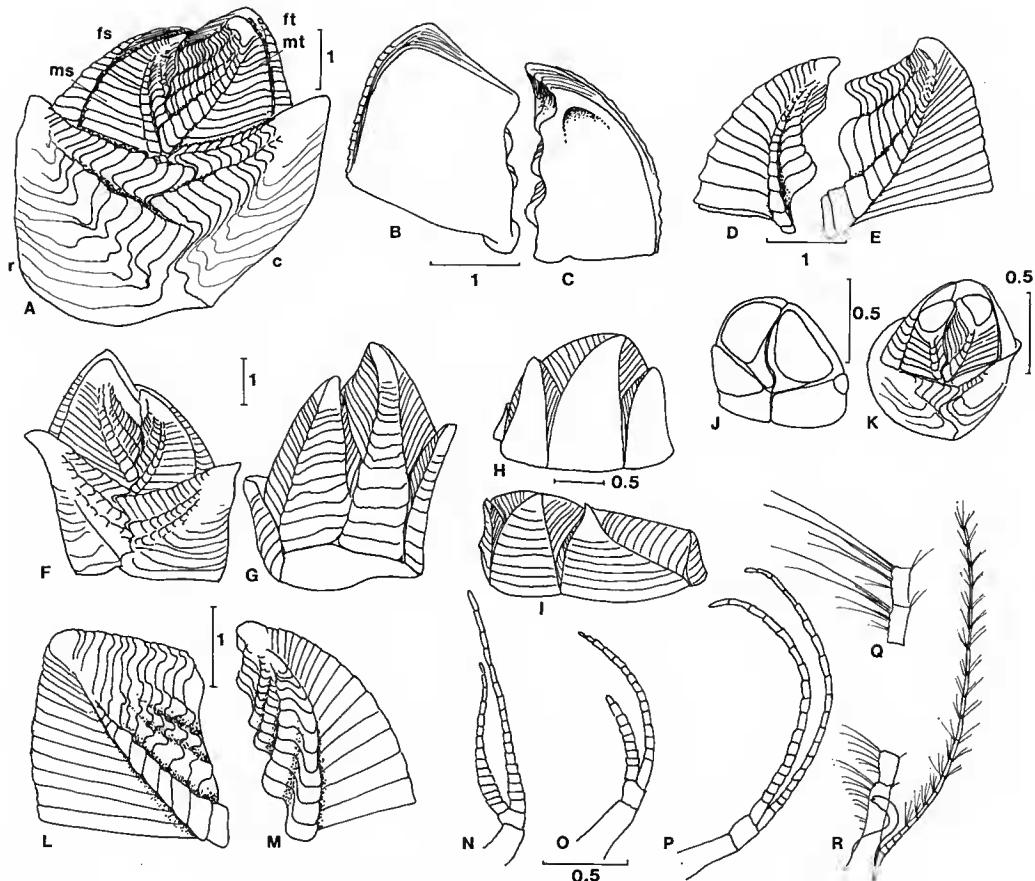


FIG. 10. — Verrucidae: *Verruca trisulcata*. A, BALGIM, CP160 (5.5 mm rcl). B, C, opercula, inner views, specimen A. D, E, opercula, outer views, BALGIM, CP160. F, G, "front" and "rear" views, BALGIM CP92 (5.0 mm rcl). H, I, "rear" views of others BALGIM CP92; same scale. J, juvenile, BALGIM, CP160 (0.8 mm rfcl). K, post-juvenile, BALGIM CP90 (1.8 mm rcl). L, M, opercula, outer views BALGIM, CP90. N, cirrus I, BALGIM, CP90 (from 5.9 mm c.l.). O, cirrus II, *dito*. P, cirrus III, *dito*. Q, intermediate segment cirrus VI, *dito*. R, pedicle cirrus VI, penis and caudal appendage, *dito*. N-R to same scale. Scales in mm. Shell plates: c, carina; fs, fixed scutum; ft, fixed tergum; ms, movable scutum; mt, movable tergum; r, rostrum. rcl = umbos of rostrum to carina length.

Verrucidae : *Verruca trisulcata*. A, BALGIM, CP160 ($r_{lc} = 5,5$ mm). B, C, opercule, vues internes, spécimen A. D, E, opercules, vues externes, BALGIM, CP160. F, G, vues antérieure et postérieure, BALGIM CP92 ($r_{lc} = 5,0$ mm). H, I, vues postérieures des autres spécimens BALGIM CP92 : même échelle. J, juvénile, BALGIM, CP160 ($r_{lc} = 0,8$ mm). K, post-juvénile, BALGIM CP90 ($r_{lc} = 1,8$ mm). L, M, opercule, vues externes BALGIM, CP90. N, cirrhe I, BALGIM, CP90 ($r_{lc} = 5,9$ mm). O, cirrhe II, *dito*. P, cirrhe III, *dito*. Q, segment intermédiaire du cirrhe VI, *dito*. R, partie basale du cirrhe VI, pénis et appendice caudal, *dito*. N-R dessinés à la même échelle. Échelles en mm. Plaques de la coquille : c, carène ; fs, scutum fixe ; ft, tergum fixe ; ms, scutum mobile ; mt, tergum mobile ; r, rostre. r_{lc} = distance séparant l'umbo du rostre de la carina.

The type locality for *V. striata* is also in the Atlantic Ocean. It seems unavoidable that *trisulcata*, *imbricata*, *striata* and *radiata* are synonymous. Because the number of articular ribs on the movable tergum is not constant, nor is the overall shell shape, it may be that *V. grimaldi*

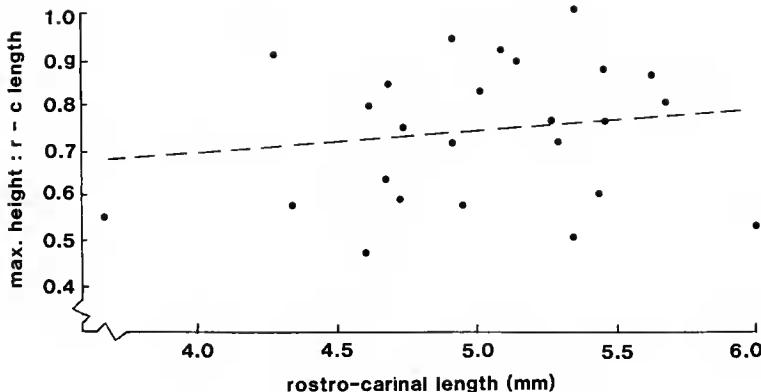


FIG. 11. — Verrucidae: *Verruca trisulcata*, BALGIM, CP92: ratio of maximum shell height to maximum shell width plotted as a function of rostrocarinal length. A ratio of 1.0 is a shell as high as wide; 0.5, half as high as wide. Regression: $y = 0.49 + 5.14x$, $n = 25$, $R = 0.028$, no significant slope.

Verrucidae: *Verruca trisulcata*, BALGIM, CP92: rapport de la hauteur maximale de la coquille à sa largeur maximale en fonction de la longueur rostrocarinale. Un rapport de 1,0 correspond à une coquille aussi haute que large ; de 0,5, moitié moins haute que large. Régression : $y = 0,49 + 5,14x$, $n = 25$, $R = 0,028$, pas de pente significative.

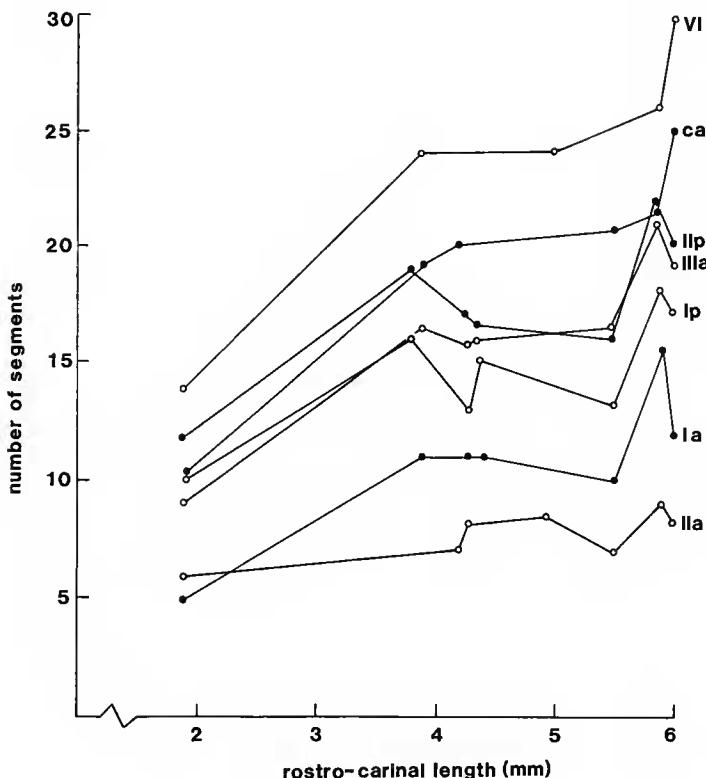


FIG. 12. — Verrucidae: *Verruca trisulcata*, BALGIM, CP92: Mean numbers of segments of rami as a function of size of specimen. For anterior (a) rami of cirri I-III and posterior (p) rami of cirri I and II, and all rami of cirri IV-VI, and caudal appendages (ca).

Verrucidae: *Verruca trisulcata*, BALGIM, CP92: Nombres moyens de segments des rames en fonction de la taille des spécimens. Rame antérieure (a) des cirres I-III, postérieure (p) des cirres I et II, ensemble des rames des cirres IV-VI, et appendices caudaux (ca).

Gruvel, 1920 from off Madeira Is, *V. entobapta* Pilsbry, 1916 from off Florida, and *V. macani* Stubblings, 1936 from off Zanzibar could be the same species.

Altiverruca gibbosa Hoek, 1883
(Fig. 13A, B)

MATERIAL. — BALGIM: CP108, 1527 m (1 empty shell).

RECORDS. — HOEK, 1883: 134, Crozet Is, 1893 m; NILSSON-CANTELL, 1928: 25, Celebes, 3056 m (see for synonymy *sulcata*, *bicornuta*, *mitra*); BROCH, 1931: 45, East Indies, 385 m; ZEVINA, 1971: 439, off Chile, 1230-1700 m; NEWMAN & ROSS, 1971: 135, South Georgia, 1098-1153 m; FOSTER, 1981: 352, Kermadec Is and Norfolk I, 590-949 m. As *gibbosa somaliensis* Nilsson-Cantell, 1929: 470, East-African coast, 1079-1289 m. As *bicornuta* Pilsbry 1916: 43, off Nantucket, 3127 m. As *sulcata* Hoek, 1883: 139, off New Zealand, 950-1165 m. As *mitra* Hoek, 1907b, Antarctic Peninsula, 555 m. As *darwini* Pilsbry, 1907a: 111, off Cape May, 2844 m. As *rathburniana* Pilsbry, 1916: 41, off Cape Cod, 3235 m; NILSSON-CANTELL, 1927: 776, Cape Verde Is, 1812 m.

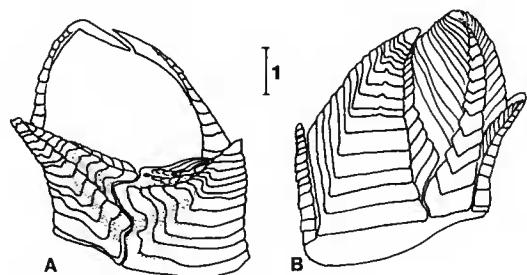
REMARKS

The single empty shell is a dirty yellow colour with clearly delimited growth lines. Basal maximum length (rostrocarinal) 4.5 mm; apical rostrocarinal length (rcl) 5.2 mm; i.e. apex of carina flared outward. Tergal height 5.0 mm. The operculum orifice is at an angle of 45 degrees to the base.

A. gibbosa is distinguished from *V. trisulcata* by the ridges and shelf above the superior articular ridge of the rostrum, and from *V. sinuosa* (above) by the very definite sculpturing of the whole shell. A single specimen does not permit any examination of existing or further synonymy, but it does show how a widely distributed, recorded and considered barnacle can be sparsely represented in intensive collecting.

FIG. 13. — Verrucidae: A, B, *Altiverruca gibbosa* BALGIM, CP108, "front" and "rear" views of empty shell. Scale in mm.

Verrucidae: A, B, *Altiverruca gibbosa* BALGIM, CP108, vues frontale et postérieure d'une coquille vide. Échelle en mm.



Altiverruca vertica n.sp.
(Fig. 14)

MATERIAL. — BALGIM: CP92, 1182 m (1 specimen: holotype MNHN Ci 2138).

DESCRIPTION OF HOLOTYPE

3.2 mm umbo rostrocarinal length (rcl); shell higher than wide, with operculum held nearly perpendicular to base. Base calcareous. Carina higher than rostrum; upper margins to movable

opercula continuous and shallowly concave. Rostrum broadly quadrangular; suture with carina without interlocking. All plates lightly sculptured with growth lines. Movable tergum square, and with 2 broad articular ribs above a barely defined diagonal rib. Movable scutum 0.5 times width of tergum, with diagonal rib placed close to articular edge, and internally with a deep muscle pit apically.

Cirrus I with anterior ramus 1 segment longer than posterior ramus. Cirri II and III with anterior rami shorter than posterior rami. Cirri IV-V damaged. Cirrus VI with 25 segments in subequal rami, and intermediate segments with 2 pairs of setae on the anterior edge. Mean segments per rami as follows, anterior ramus first:

I	II	III	IV	V	VI	ca
10,9	7,10	13,16	20,22	—	25,25	7

Caudal appendages 0.5 times length of basal podomere of pedicle of cirrus VI.

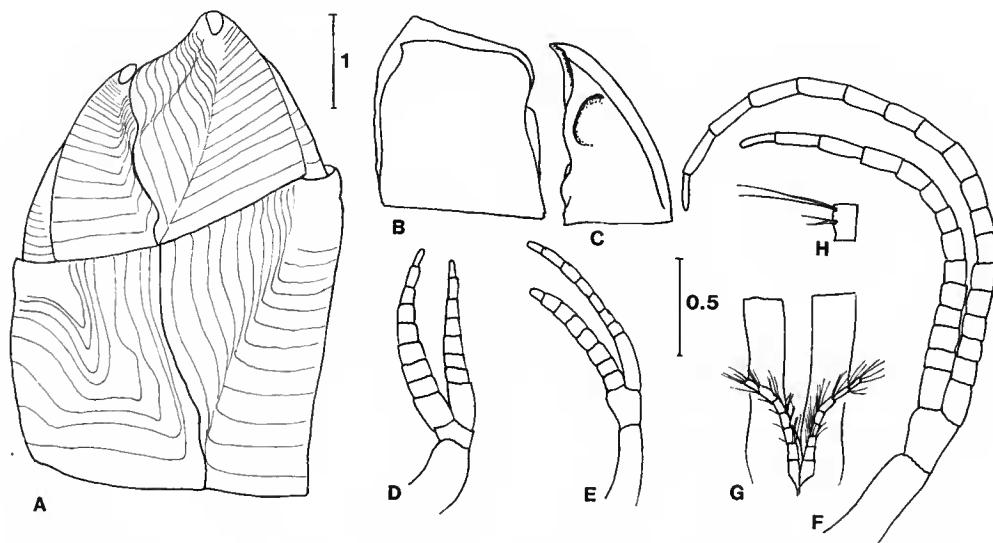


FIG. 14. — Verrucidae: *Altv verruca vertica* sp. nov. Holotype BALGIM, CP92: A, holotype (3.2 mm rcl). B, C, tergum and scutum, inner views. D, cirrus I. E, cirrus II. F, cirrus III. G, pedicles of cirri VI and caudal appendages. H, intermediate segment of cirrus VI. Scales in mm.

Verrucidae : *Altv verruca vertica* sp. nov. Holotype BALGIM, CP92 : A, holotype (lrc = 3,2 mm). B, C, tergum et scutum, vues internes. D, cirrhe I. E, cirrhe II. F, cirrhe III. G, partie basale des cirrhes VI et appendices caudaux. H, segment intermédiaire du cirrhe VI. Échelles en mm.

REMARKS

This species is represented by a solitary specimen. It is similar to *quadrangularis*, being lightly sculptured, smooth surfaced, the operculum held at a steep angle to the base, and the

rostrum and carinal in “front” view broadly quadrangular, but there is no interlocking between rostrum and carina; further, the scutum is much narrower. The specimen is larger than the largest *V. quadrangularis*, and it is notable that the caudal appendages are more diminutive. The shell resembles *V. casula* Hoek, 1913, of Malaysian seas; the appendages of *V. casula* have not been described, and *V. casula* is notable for the broad rostral rib interlocking with the carina.

Metaverruca recta (Aurivillius, 1898)
(Fig. 15)

MATERIAL. — BALGIM: CP92, 1182 m (10 specimens); CP95, 1378 m (9); CP97, 1515 m (2); CP109, 1200 m (1); DW157, 1108 m (1). EPI I: CP38 (Celtic Sea), 2100 m (1).

RECORDS. — AURIVILLIUS, 1898: 195 and GRUVEL, 1920: 46, Azores, 861-1385 m; SOUTHWARD & SOUTHWARD, 1958: 637, Bay of Biscay, 329-1774 m. As *sculpta* Aurivillius, 1898: 197 and GRUVEL, 1920: 41, Azores, 454 m; NILSSON-CANTELL, 1929: 461, Scotland, 1326 m; BROCH, 1931: 41, Kei Is., 345 m; FOSTER, 1981: 352, Kermadec Is., 501-1180 m. As *magna* Gravel, 1901: 261; 1902: 109, Gulf of Gascogne, 1480 m; GRUVEL, 1920: 50. As *linearis* Gravel, 1900b: 243 and GRUVEL, 1902: 107, Azores, 960-2018 m. As *halotheca* Pilsbry, 1907b: 188, Hawaii, 1670 m; Pilsbry, 1916: 46, Hawaii, 417-430 m; FOSTER, 1978: 69, New Zealand, 252-896 m. As *capsula* Hoek, 1913: 130, East Indies, 520-1301 m; STUBBINGS, 1936: 38, Zanzibar, 333 m. As *coraliophila* Pilsbry, 1916: 21, Florida — Bahamas, 506-794 m. As *sculpta* Buckeridge, 1983: 59; Miocene of New Zealand; BUCKERIDGE, 1994: 116 (for full synonymy); FOSTER & BUCKERIDGE, 1994: 368, La Réunion, 620-1230 m.

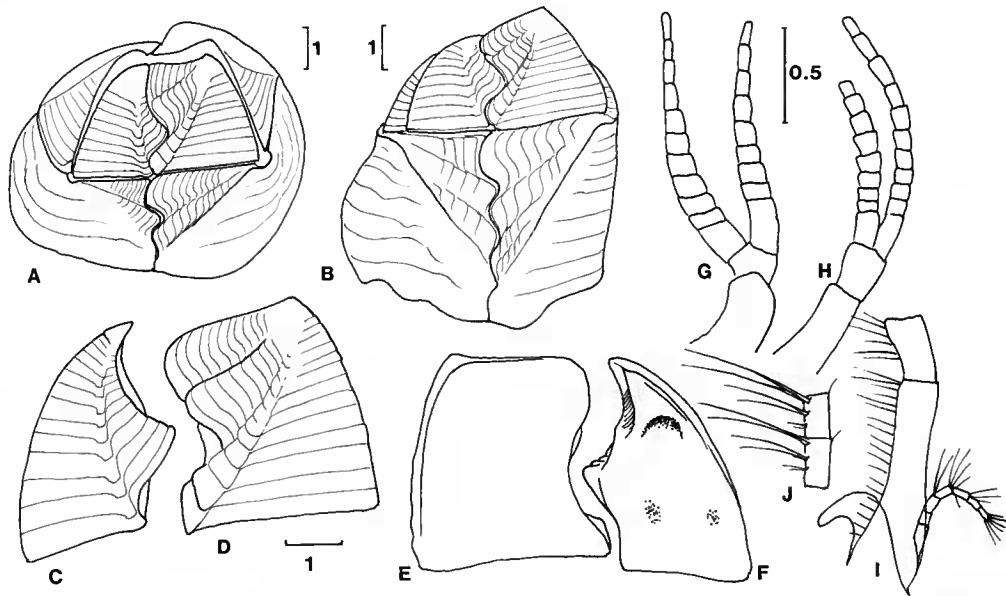


FIG. 15. — Verrucidae: *Metaverruca recta*, A, top view (4.5 mm rcl) BALGIM, CP95. B, oblique view (5.1 mm rcl) BALGIM, CP92. C, D, outer views scutum and tergum (of 5.1 mm rcl specimen) BALGIM, CP92. E, F, inner views, *dito*. G, cirrus I; H, cirrus II; I, pedicle cirrus VI, penis and caudal appendages; J, intermediate segments cirrus VI; all of 5.0 mm rcl specimen, BALGIM, CP95, and all to same scale. Scales in mm.

Verrucidae: *Metaverruca recta*, A, vue de dessus (lrc = 4,5 mm) BALGIM, CP95. B, vue oblique (Rcl = 5,1 mm) BALGIM, CP92. C, D, vues externes du scutum et du tergum (spécimen ayant une lrc de 5,1 mm) BALGIM, CP92. E, F, vues internes, *dito*. G, cirrhe I; H, cirrhe II; I, partie basale du cirrhe VI, pénis et appendices caudaux; J, segments intermédiaires du cirrhe VI; provenant tous d'un spécimen ayant une lrc de 5,0 mm, BALGIM, CP95, et tous à la même échelle. Échelles en mm.

REMARKS

Accepting the synonymies, this is a widespread barnacle, from North Atlantic through Indian to North and South Pacific Oceans. It is characterised by its particularly compact form, more roundly sessile than narrowly erect like *V. quadrangularis*, with the apices of the rostrum and tergum set in from the basal margin (*i.e.* the shell is conical rather than splayed), with the upper ribs between the rostrum and carina very wide, mostly 2, sometimes 3 of them; by the edge of articulation of the movable plates forming a straight line between the apices of the rostrum and carina; by the general D-shape of the orifice; by the operculum being held at an angle 45-90 degrees to the perpendicular depending on the nature of the substratum; by the myophores; and by the generally large size of grown specimens for the genus (8-10 mm basal length). The appendages have been described by FOSTER (1978) and BUCKERIDGE (1994); notable is the shortness of the caudal appendages.

Mean numbers of segments in cirri of 4 specimens (CP95) as follows, anterior ramus first:

rcl (mm)	I	II	III	IV	V	VI	ca
1.0	6.5	5.6	8,10	15,17	16,14	14,17	5
1.3	7.6	5.7	9,12	15,16	19,19	21,21	5
2.9	12,9	8,11	18,21	22,26	26,28	30,31	7
4.3	12,10	8,12	19,20	20,21	23,22	20,21	7

Family PACHYLASMATIDAE Buckeridge, 1983

Pachylasma giganteum (Philippi, 1836)
(Fig. 16A, B)

MATERIAL. — BALGIM: DR37, 864 m (3 shells); DR40, 362 m (75 specimens, 14-34 mm basal diameter); DR49, 521 m (1 specimen); DR111, 285 m (6 specimens); DR115, 352 m (1 shell); DW116, 340 m, (1 shell); DR152, 550 m (1 shell); DR153, 580 m (99 specimens, 6-47 mm basal diameter).

RECORDS. — DARWIN, 1854: 477, Mediterranean; PILSBRY, 1916: 329, Strait of Messina; STUBBINGS, 1967: 263, off West Africa; WELTNER, 1897: 273, Mediterranean, on *Errina aspera*; RELINI, 1980: 49, Italy, 150-200 m. See NEWMAN & ROSS (1976: 40) for full synonymy; distribution quoted as "Mediterranean – West Coast Africa".

REMARKS

This barnacle is well described by DARWIN (1854), who quoted a maximum size of 29.2 mm basal rostrocarinal length. Very small specimens have no carinolatera. Few of the records of this barnacle give depth data. The present records are precise, 285-864 m, just west of the Straits of Gibraltar. Four of the stations yielded only shells (easily recognised by their thickness and the irregular basal edges) and 2 of the stations yielded rock substratum with large numbers of specimens growing on it and themselves.

Family BATHYLASMATIDAE Newman & Ross, 1971

Bathyasma hirsutum (Hoek, 1883)
(Fig. 16C, D)

MATERIAL. — BALGIM: CP36, 990 m (1 shell only); DR37, 864 m (72 shells).

RECORDS. — See NEWMAN & ROSS (1976: 46) for full references, and distribution "Northeast Atlantic from Faroe Is to Azores, 944-1829 m". SOUTHWARD & SOUTHWARD (1958) give a useful list of collecting data, including depth range of 384-1829 m.

REMARKS

These 2 stations are a little further south than the stations listed by SOUTHWARD & SOUTHWARD (1958) but do not constitute a significant addition to the known distribution. The large number of shell plates at Stn DR37 (Bay of Cadiz) is quite reminiscent of similar collections of plates of *B. corolliforme* from the Southern Ocean (NEWMAN & ROSS, 1971) and of *B. alearum* from New Zealand (FOSTER, 1978). Evidently, the shell plates of deep water bathylasmatids accumulate in-situ in proximity to appropriate attachment substrata, and in themselves provide substrata for further recruitment and accumulation.

Family BALANIDAE Leach, 1817

Megabalanus tulipiformis (Ellis, 1758)
(Fig. 16E, F)

MATERIAL. — BALGIM: DR40, 362 m (4 shells); DR115, 352 m (1 shell plate); DR133, 195 m (1 specimen).

DISTRIBUTION. — Mediterranean, east Atlantic of France to Cape Verde Is, 25-250 m (NEWMAN & ROSS, 1976: 69; RELINI, 1980: 53).

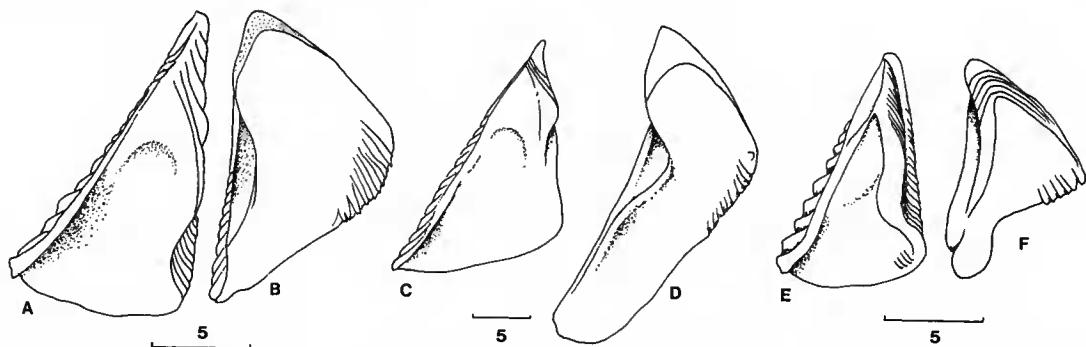


FIG. 16. — Balanomorpha, inner views of opercula: A, B, *Pachylasma giganteum*, scutum and tergum, same individual, BALGIM, DR40. C, D, *Bathyasma hirsutum*, ditto, different individuals, BALGIM, DR37. E, F, *Megabalanus tulipiformis*, ditto, same individual, BALGIM, DR133. Scales in mm.

Balanomorpha, opercule, vues internes : A, B, Pachylasma giganteum, scutum et tergum d'un même individu, BALGIM, DR40. C, D, Bathylasma hirsutum, ditto, provenant de divers individus, BALGIM, DR37. E, F, Megabalanus tulipiformis, ditto, d'un même individu, BALGIM, DR133. Échelles en mm.

REMARKS

Previous authors have noted the occurrence of *M. tulipiformis* with *Pachylasma giganteum*. The single shell plate recovered from station DR115 together with *P. giganteum* was readily identified by its rose pink colour. In the BALGIM collections, *M. tulipiformis* is the only barnacle recovered from any station in the Mediterranean (DR133), and it was the only live material of this species.

BIOGEOGRAPHY

Summary data are presented in Table 1, which gives the number of stations, number of individuals and depth data from these collections and from the literature, for each of the species. Full station data are given in Appendix A.

The frequency of recovery of barnacles in the deep sea grabs and dredges is 23% (29 of 126 stations) for the BALGIM cruise, yielding 882 specimens (14 species).

The North Atlantic Ocean stations (29 BALGIM plus 9 others) provided 20 species, including 2 new to science (*Arcoscalpellum crenulatum* and *Verum frillosum*).

There are 5 species common to New Zealand and the North Atlantic (*Poecilasma kaempferi*, *Smilium acutum*, *Verum novaezelandiae*, *Altiverruca gibbosa* and *Metaverruca recta*). These seem to be part of a circumglobal, or at least North Atlantic to South-West Pacific barnacle fauna, in moderately deep water (1000-2000 m).

Whether deeper sea (> 3000 m) species such as *Trianguloscalpellum gigas*, *T. regium*, *Arcoscalpellum michelottianum* and *Meroscalpellum bifurcatum* are widespread is hard to ascertain from published records, but considering the more limited sampling from such depths they are likely to be so.

The more commonly collected species (*i.e.*, 100 specimens) are: *A. michelottianum*, taken at 11 stations (121 specimens), *Verruca trisulcata*, at 10 stations (400 specimens), and *Pachylasma giganteum*, at 4 stations (181 specimens). The last of these, the shallowest occurring, is most likely restricted to the northern Atlantic Ocean and the Mediterranean Sea. The predominance of records from the North Atlantic, possibly reflects a longer history of collecting there. Biogeographic restrictions are likely to apply to other shallower sea species, (*e.g.*, for the North Atlantic *Scalpellum scalpellum*, *Ornatoscalpellum stroemii*, *Bathylasma hirsutum* and *Megabalanus tulipiformis*), as they are to littoral species.

With respect to a principal aim of the BALGIM cruise, namely to relate Mediterranean outflow water to its deflection to the northern side of the Ibero-Moroccan Bay, it is noteworthy that stations that have *Bathylasma hirsutum*, *Pachylasma giganteum* or *Megabalanus tulipiformis*, do not have verrucomorphs or lepadomorphs. Only one of these stations is in the Mediterranean Sea (DR133, which has *M. tulipiformis* only, and is the only station there to provide barnacles), two are on the sill of the Straits of Gibraltar (DR152 and DR153, with *P. giganteum* only), five are grouped just due west of the sill (DR40, DR49, DR111, DR115 and DW116, with both *M. tulipiformis* and *P. giganteum*), and two further northwest (CP36 and DR37, both with *P. giganteum* and *B. hirsutum*). The Mediterranean barnacle fauna does not have the deep ocean scalpellids and verrucids. The last 9 quoted stations are different from the other Atlantic stations, and could represent a Mediterranean influence.

TABLE 1. — Summary data on numbers of stations, individuals and depths for each of the species.

Species	No of stations	Indiv. sample numbers	Total no	Depth range (m)	
				this paper	literature
<i>Octolasmis niestraszi</i>	1	1	1	80	16-135
<i>Poecilasma kaempferi</i>	1	1	1	1108	126-1885
<i>Smilium acutum</i>	8	1 3 23 45 1 1 3	41	355-2170	61-2480
<i>Trianguloscalpellum regium</i>	2	22 1	23	3100-3380	845-5212
<i>Trianguloscalpellum gigas</i>	1	3	3	3815	3749
<i>Arcoscalpellum michelottianum</i>	11	14 3 27 5 10 2 15 25 9 10 1	121	1182-2160	64-3422
<i>Arcoscalpellum crenulatum</i> n. sp.	1	2	2	3100	—
<i>Amigdoscalpellum praeceps</i>	2	1 1	2	3100-4720	411-2940
<i>Verum?</i> <i>minutum</i>	3	13 3 3	19	1870-2077	802-3520
<i>Meroscalpellum bifurcatum</i>	2	1 1	2	46613-4720	4151
<i>Verum novaezelaniae</i>	4	1 14 7 1	23	1592-2100	455-2500
<i>Verum frillorum</i> n. sp.	1	1 3	1	3380	—
<i>Ornatocalpellum stroemii</i>	1		3	355	160-629
<i>Scalpellum scalpellum</i>	1	21	21	347	50-400
<i>Verruca tricusculata</i>	7	9 4 70 252 28 9 22	394	890-1378	441-1690
<i>Altiverruca gibbosa</i>	1	(1)	(1)	1527	555-1289
<i>Altiverruca vertica</i> n. sp.	1	1	1	1182	—
<i>Metaverruca recta</i>	6	10 9 2 1 1 1	24	1108-2100	329-2110
<i>Pachylasma giganteum</i>	8	(3) 75 1 6 (1) (3) 75 1 6 (1) (1) 99	187	285-864	150-250
<i>Bathyslama hirsutum</i>	2	(1) (72)	73	864-990	944-1829
<i>Megabalanus tulipiformis</i>	3	(4) (1) 1	6	135-195	

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APPENDIX A. — Cruise and station data, and barnacles and numbers of barnacles collected at each station.

ATLANTIC OCEAN

BALGIM. — A study to correlate composition of benthic fauna and origin of water masses between the Atlantic Ocean and Mediterranean Sea. This material was collected May-June 1984 aboard R.V. "Cryos" during cruise BALGIM, conducted for Centre national de la recherche scientifique (PIROCEAN), under the direction of Dr P. BOUCHET (Museum). Dates: 29.5.84-18.6.84.

Stn	m	°N	°W	Species	#
CP10	1592	36.453	9.320	<i>Arcoscalpellum michelottianum</i>	14
				<i>Verum novaezelandiae</i>	1
CP17	1470	36.453	9.308	<i>Arcoscalpellum michelottianum</i>	3
CP36	990	36.166	7.137	<i>Bathylasma hirsutum</i>	(1)
DR37	864	36.178	7.154	<i>Pachylasma giganteum</i>	(3)
				<i>Bathylasma hirsutum</i>	(72)
DR40	362	35.499	6.086	<i>Pachylasma giganteum</i>	75
				<i>Megabalanus tulipiformis</i>	(4)
DR49	521	35.530	6.328	<i>Pachylasma giganteum</i>	1
CP63	1510	35.306	7.421	<i>Arcoscalpellum michelottianum</i>	27
CP65	1805	35.265	7.599	<i>Smilium acutum</i>	1
				<i>Arcoscalpellum michelottianum</i>	5
CP68	2035	35.119	7.526	<i>Smilium acutum</i>	3
				<i>Arcoscalpellum michelottianum</i>	10
				<i>Verum ? minutum</i>	13
CP69	2028	35.114	7.505	<i>Smilium acutum</i>	23
				<i>Arcoscalpellum michelottianum</i>	2
				<i>Verum ? minutum</i>	3
DR82	355	33.455	8.320	<i>Smilium acutum</i>	4
				<i>Ornatocalpellum stroemii</i>	3
CP90	890	34.214	7.236	<i>Verruca trisulcata</i>	9
CP91	948	34.223	7.251	<i>Verruca trisulcata</i>	4
CP92	1182	34.243	7.303	<i>Arcoscalpellum michelottianum</i>	15
				<i>Verruca trisulcata</i>	70
				<i>Altiverruca vertica</i>	1
				<i>Metaverruca recta</i>	10
CP95	1378	34.240	7.393	<i>Arcoscalpellum michelottianum</i>	25
				<i>Verruca trisulcata</i>	22
				<i>Metaverruca recta</i>	9

CP97	1515	34.254	7.411	<i>Arcoscalpellum michelottianum</i>	9
				<i>Metaverruca recta</i>	2
CP99	1870	34.282	7.433	<i>Arcoscalpellum michelottianum</i>	10
				<i>Verum ? minutum</i>	3
CP103	347	34.107	7.298	<i>Scalpellum scalpellum</i>	21
CP108	1527	36.108	8.062	<i>Altiverruca gibbosa</i>	(1)
CP109	1200	36.145	7.564	<i>Metaverruca recta</i>	1
DR111	285	35.569	6.221	<i>Pachylasma giganteum</i>	6
DR115	332	35.475	6.042	<i>Pachylasma giganteum</i>	(1)
				<i>Megabalanus tulipiformis</i>	(1)
DW116	340	35.486	6.042	<i>Pachylasma giganteum</i>	(1)
DR133	195	35.258	4.174	<i>Megabalanus tulipiformis</i>	(1)
DR152	550	35.567	5.347	<i>Pachylasma giganteum</i>	(1)
DR153	580	35.558	5.353	<i>Pachylasma giganteum</i>	99
CP156	1135	36.200	7.527	<i>Poecilasma kaempferi</i>	1
				<i>Verruca trisulcata</i>	252
DW157	1108	36.210	7.558	<i>Poecilasma kaempferi</i>	1
				<i>Verruca trisulcata</i>	28
				<i>Metaverruca recta</i>	1
CP160	1350	36.146	8.009	<i>Verruca trisulcata</i>	9

BAY OF BISCAY. — This material was collected during missions organised by IFREMER (Brest) between 1974 and 1987.

BIOGAS V					
CP07	2170	44.098	4.164	<i>Smilium acutum</i>	5
BIOGAS VII					
CP28	3380	47.295	9.035	<i>Trianguloscalpellum regium</i>	2
				<i>Scalpellum frillosum</i>	1
BIOGAS VIII					
CP30	3100	47.296	9.061	<i>Veruum regium</i>	21
				<i>Arcoscalpellum crenulatum</i>	2
				<i>Amigdoscalpellum praeceps</i>	1
BIOGAS XI					
CP35	4720	46.343	10.230	<i>Arcoscalpellum praeceps</i>	1
				<i>Meroscalpellum bifurcatum</i>	1
EPI I					
CP38	2100	47.338	8.422	<i>Smilium acutum</i>	1
				<i>Veruum novaezelandiae</i>	14
				<i>Metaverruca recta</i>	1
CP39	2100	47.320	8.384	<i>Verum novaezelandiae</i>	7
				<i>Smilium acutum</i>	1

EPI VI

KG229

2160 47.270 8.320 *Arcoscalpellum michelottianum* 1

GASCOR. — This material was collected during mission GASCOR, from deep-sea modules placed by EPI (Environnement Profond: Impact), organised by IFREMER, Brest; chief, Gerard AUFFRET. Date: 16.3.86.

CP42 3815 46.227 12.368 *Trianguloscalpellum gigas* 3

BIOCYAN. — This material was collected during mission BIOCYAN 2, with submersible CYANA, organised by Centre océanologique de Bretagne (COB, Brest); chief, Myriam SIBUET. Date: 26.6.83.

PL18 2000 47.321 8.276 *Smilium acutum* 3

WALDA. — This material was collected during mission WALDA, organised by Centre océanologique de Bretagne (COB, Brest). Collected off Angola. Date: 23.6.71.

CY09 4613 19.103 9.181 ^{°S} ^{°E} *Meroscalpellum bifurcatum* 1

SOUTH-WEST PACIFIC

CORINDON II. — This material was collected during the cruise CORINDON II, organised by ORSTOM: Responsible for biological data. Jacques FOREST (Museum). Dates: 29.10.80-12.11.80. Straits of Makassar, 15-2 400 m.

236 1730 0.067N 119.455 *Verum novaezelandiae* 1
248 170 0.542S 119.287 scalpellid juvenile indet.
263 80 1.568S 119.167 *Octolasmis nierstraszi* 1